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(54) Method and apparatus for surface area liquid transfer.

(57) It is known in clinical analyzers to dispense patient sample on to a test element using metering pipettes. Dispensing using such pipettes may introduce problems, such as, flow irregularities in the test element, which influence the reliability of the test results obtained. Described herein is apparatus and method for uniformly transferring a liquid material to a test element in which a transfer element (10) having a body portion (2) and a liquid-impermeable supporting surface (6, 7, 8) which has an area approximately equal to the surface area subtended by the test volume of the test element, is brought into direct contact with the test surface of the test element so that the liquid is transferred instantaneously over the entirety of the surface area of the test element.

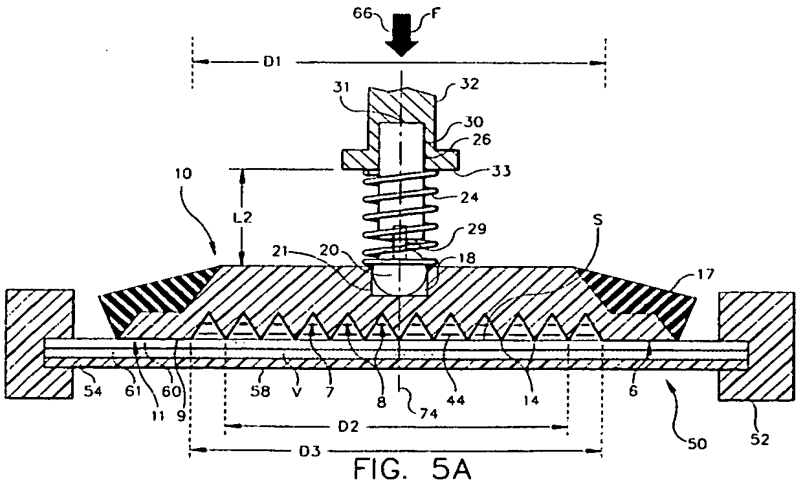

FIG. 5A

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The present invention relates to a method and apparatus for surface area liquid transfer, for use in clinical analyzers for testing of liquid analytes, and is particularly concerned with a method and apparatus for transferring patient sample to a test element in such analyzers.

In the field of clinical analyzers for the testing of liquid analytes, a patient sample is introduced and caused to interact with a reaction chemistry to produce a signal involving the analyte of choice, for detection by a sensing apparatus. A preferred technique used by analyzers involves the so-called dried assay technology so that patient sample is applied to dried test slide elements, each having a dried reactant layer. Analyzers and test elements using this technology include those manufactured by Eastman Kodak Company, both under the trademark "EKTACHEM™ ".

In a conventional operation, a patient sample is conveyed to a processing station within an analyzer where it is dispensed on to a test element. The sample is dispensed by means of a point source, usually a disposable pipette tip, which is positioned a short distance above the test element surface and has a tip orifice from where the sample is expelled (or metered) on to the test element. A metering tip method of dispensing patient liquid is described in US-A-5 143 849.

However, there are a number of problems relating to a metering technique such as those typically described.

First, it is important to understand that sample delivered from a point source has to spread horizontally, as well as vertically, through the predetermined test volume of the test element. The need for both directions of spreading introduces the possibility of flow irregularities.

Second, the reliability of test results is impacted by the sensitivity occurring due to differences in the makeup of samples between patients. For example, a patient may have a serum, plasma or whole blood sample which may contain a high fat content, (that is, containing a higher percentage of lipids and lipo-proteins than a "normal" patient). These sorts of differences are not, however, limited to non-average patients; differences in samples between patients in the so-called "normal" range may also impact the accuracy of test results.

In some cases, the presence of varying amounts of biological components and salts in the patient sample can produce a variation in the sample's viscosity, surface tension and contact angle, impacting its ability to outwardly spread in a uniform manner when dispensed as a drop from a suspended pipette tip on to a test element. Non-uniformity in the spreadability of a patient liquid may affect the accuracy of the detection of the analyte of choice, especially if the analyzer detection means is focused on only a portion of the chemistry portion of the test element on to which a patient sample has been dispensed. This type of non-uniformity is possible with any body fluid, such as blood serum, urine, and so forth, and may extend as well to control or calibration liquids that are commonly utilized in known clinical analyzers.

The above problems are generally known as "matrix effects" and are based on differences in patient liquid samples, as well as sample interaction with the spreading layer of the chemistry portion of a test element. The spreading layer assists in the migration of the liquid sample across the chemistry portion of the element and in general it works well to counter these effects. An example of a spreading layer is described in greater detail in US-A-3 992 158.

However, the requirement that a spreading layer be added to the chemistry portion of a test element to promote sample migration is expensive and complex. In addition, and notwithstanding the use of a spreading layer, point source dispensing systems have other drawbacks. For example, it is usually required that an additional volume of patient liquid be dispensed on to the test element to provide a sufficiently uniform detection or read area. Typically as much as 10μl of a patient liquid can be required to produce an effective read area having a diameter of 3mm. This, in turn, also requires that the chemistry portion of the test element be provided with a larger surface area to accept the additional volume of patient liquid dispensed on to the test element. Further, the dispensing of additional quantities of patient liquid from a point source above the test element also increases the probability of outwardly diffusing or washout of the reaction chemistry, effectively diluting the chemical portion of the test element.

There are other effects which may produce test variability which result from dispensing a volume of liquid sample from a point source. The ability of a point source, such as a pipette tip, to adequately target on to a test element so that it can be analyzed is directly influenced by flow characteristics of the liquid to be tested. These characteristics are affected by factors such as the viscosity, surface tension, contact angle and temperature of the liquid, the volume dispensed, shape of the tip nozzle, the distance the tip is suspended above the test element, the centering of the tip above the test slide, and the makeup of the sample to be tested.

Other factors such as the amount of ambient air flow in the vicinity of the dispensed liquid, must also be considered, and all factors may impact upon the accuracy of results. In addition, it is also known that liquid dispensed by a suspended point source has a tendency to move up the exterior surface of the dispensing container, rather than

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down on to the test element designed to receive the liquid. This problem, known as perfusion, has been an occasional but persistent problem with clinical analyzers using the dispensing means described, altering the volume of liquid which is subsequently dispensed. In addition, the horizontal or outward flow of a point source dispensed liquid varies over time, affecting in particular rate-type chemistries which are also time dependent.

It has been a problem, therefore, to provide a metering method which will allow patient liquid to be deposited on to a test element without the variability in testing results which are possible using known point source techniques.

It has also been a problem to provide a method of dispensing a smaller quantity of a patient liquid on toa test element in a substantially uniform manner which will minimize the flow characteristics of the dispensed liquid, as well as washout, and produce an effective detection area for an analyzer.

There is a further problem of providing a method of dispensing a patient sample to a test element which will obviate the current needs of requiring a spreading layer to horizontally and uniformly spread a liquid patient sample over the detection area of a test element, thereby also simplifying their design and manufacture.

The present invention solves the above stated needs by providing a method and related means of metering a sample on to a test element without concern for the effects of fluid adhesion or flow characteristics of a particular biological liquid which occur when dispensing from conventional point source metering systems on to a relatively large test slide surface area.

More specifically, in accordance with one aspect of the present invention, there is provided a method of dispensing a liquid sample on to a test element having a test volume subtending a surface area for that volume for receiving the liquid sample, the method comprising the steps of:-

a) applying on to a transfer element having a liquid-supporting surface for supporting a liquid, a quantity of liquid sample over substantially all of the liquid-supporting surface; and

b) placing the liquid-supporting surface of the transfer element in contact with all of the surface area of a test element at once, thereby transferring the liquid sample as a surface-dispersed quantity to the test element without the need for extensive horizontal flow over the surface area of the test element.

In accordance with another aspect of the present invention, there is provided a liquid dispensing device for dispensing a liquid sample on to a test element having a test surface, the device comprising:-

a main body portion;

a transfer portion supported by the main body portion for engagement with a test element, the transfer portion having a liquid-impermeable supporting surface for supporting a liquid over an area approximately equal to the area of the test surface of the test element; and

absorbing means disposed about the periphery of the transfer portion for absorbing excess liquid from the liquid-impermeable supporting surface prior to dispensing therefrom.

By this arrangement, it is possible to transfer the liquid sample instantaneously over the entirety of the surface area of the test element.

Thus, it is an advantageous feature of the invention that a method and associated apparatus are provided in which a liquid sample can be applied on to a test slide element which prespreads the liquid uniformly over a contact surface area which matches the test element test surface area, thus negating the matrix effects which impact the diffusivity of conventionally dispensed systems.

Another advantageous feature of the invention is that a smaller quantity of liquid can be directly and evenly applied to the test volume of a test element with reduced consideration of the fluid characteristics of a dispensed liquid from a suspended tip.

A further advantageous feature of the invention is that the ability to uniformly dispense a patient liquid on to a test element eliminates the necessity for a test element having a pre-incorporated horizontally diffusing spreading layer thereby allowing test elements to be manufactured more easily and inexpensively.

A still further advantageous feature of the present invention is that by uniformly distributing a patient sample to the test volume of a test element there is provide less need for an oversized chemistry portion to provide an adequately sized detection area, thereby producing an additional and significant savings in the manufacture of test elements.

A still further advantageous feature of the present invention is that a surface-dispersed quantity, as defined below, can be delivered to the test volume of a test element all at once, providing a relatively constant concentration level of liquid across the detection read area without significant washout of the dried chemistry or transient liquid flow after delivery.

For a better understanding of the present invention, reference will now be made, by way of example only, to the accompanying drawings in which:-

Figure 1 is a sectioned fragmentary side elevational view of a fluid dispensing apparatus according to the present invention;

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Figures 2A and 2B are bottom views of the apparatus shown in Figure 1 illustrating preferred embodiments of a lower liquid-supporting surface of the apparatus;

Figures 3A and 3B are sectioned fragmentary side elevational views of the apparatus shown in Figure 1, illustrating the transfer of a liquid from a source to the liquid-supporting surface of the apparatus of Figures 1 and 2A;

Figures 4A and 4B are partly sectioned fragmentary side elevational views of the apparatus shown in Figures 1 to 3, illustrating the removal of excess fluid from the liquid-supporting surface prior to the dispensing of fluid on to a test element;

Figures 5A and 5B are sectioned fragmentary side elevational views of the apparatus shown in Figures 1 to 4 illustrating the instantaneous dispensing of a patient liquid on to the entire test surface of a test element;

Figure 6 is a partly sectioned fragmentary side elevational view of the fluid dispensing apparatus shown in Figures 1 to 5 illustrating the dispensing of liquid on to a misaligned test element;

Figure 7 is a partial top view of the test element shown in Figures 5A and 5B after a liquid has been dispensed thereto illustrating the sizing of a chemistry portion of the test element in accordance with the present invention with that of a known test element; and

Figures 8A and 8B are plots illustrating the advantageous features of liquid delivered to a test element using the invention shown by Figures 1 to 7 as compared with prior delivery systems.

The invention is hereinafter described in the context of the preferred embodiments. In addition, the invention is useful regardless of the liquid being dispensed, the kind of analyzer which is being used, and regardless of whether the surface is a dried slide test element, or even any kind of test element, since the described methods and associated apparatus can also be used to meter on to any surface.

Terms such as "up", "down", "lower", "vertical", "horizontal", and "bottom" as used herein refer to the orientation of parts when the apparatus is positioned in its customary position of use. The term "surface-dispersed quantity" means, a quantity in which the surface area/volume ratio is approximately 1:1, for example, if a $10cm^3$ volume has a $10cm^2$ dispersed surface area and a 1cm thickness, its ratio is 1:1. Ratios of 9:10 or 11:10 are included here.

A preferred embodiment of the present invention is shown in Figures 1, 2A, and 2B.

Referring to Figure 1, a transfer element 10 is shown having a main body 2 comprising an upper surface 4 and a preferably circular lower surface 6. The shape of lower surface 6 may be varied, but preferably should be congruent with the shape of the test surface area to be contacted, whatever that may be.

Referring to Figure 2A, lower surface 6 is defined, in part, by a liquid-supporting portion 7 defined by a series of substantially parallel, V-shaped grooves 8, disposed over the majority of the area of surface 6. The shapes and depths of grooves 8, however, may be varied to be rectangular, convex, concave, U-shaped, and so forth. Alternate configurations can also be provided for defining liquid supporting portion 7; for example, a diamond-like pattern such as illustrated in Figure 2B. In the embodiment illustrated in Figures 1 and 2A, grooves 8 have a depth of 200μm and a spacing of 400μm.

Further, liquid-supporting portion 7 can alternatively be textured (not shown), as opposed to providing grooves, provided capability is provided for supporting a sufficient quantity of liquid to effectively coat the reagent member, or other reactive portion of a test element.

Lower surface 6 is further defined by a ring portion 11, preferably circumferentially and substantially disposed about the entire outer periphery 5 of liquid-supporting portion 7, and having an outer peripheral edge 16. Preferably, ring and liquid-supporting portions 7, 11 are made from the same material, except that ring portion 11 is smooth. Though main body 2, Figure 1, can be constructed of almost any material, it is preferred that lower surface 6 be made from a compliant and liquid-impermeable material. In the embodiment illustrated, main body 2, including lower surface 6, is made from a plastic with minimal protein adhesion, such as polypropylene or polyethylene. Ring portion 11 and liquid-supporting portion 7 further define a diameter D1 which is preferably at least equal to the detection or read area of the chemistry portion of a test element.

Referring to Figures 1 and 2A, grooves 8 are formed in surface 6 between ring portion 11, to form a series of ribs 14. In the present embodiment, ribs 14 are rounded, though this may not be required if lower surface 6 is made from a fairly compliant material, so as not to damage the chemistry portion of a test element when brought into contact therewith. Contacting surface 9 of ring portion 11 is made to be flush with ribs 14, ring portion 11 being substantially continuous with the exception of a variable number of small vent channels 12.

To absorb excess liquid at the periphery of surface 6, a disc 17, Figure 1, made of a liquid

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absorbent material is preferably continuously disposed about main body 2, adjacent outer peripheral edge 16 and generally in contact with ring portion 11, except in the vicinity of vent channels 12, Figure 2, where it is slightly undercut so as not to prematurely siphon liquid from grooves 8. Alternately, cross-channels (not shown) arranged substantially perpendicular to grooves 8 can also be provided across surface 6 for this purpose. In the embodiment illustrated, disc 17 is made of a high density open-cell urethane foam, though other nonreactive, liquid absorbing materials such as an absorbent paper may be provided. Disc 17 is made to extend inwardly radially from edge 16, attaching to upper surface 4.

Transfer element 10 is preferably made to be both pivotably and vertically movable. Referring to Figure 1, a ball 20, is seated within a centrally disposed recess 18 defined in upper surface 4. Preferably, recess 18 is an opening sized to receive ball 20 and is defined by a substantially orthogonal configuration, having a bottom surface 15 and side seating surfaces 21. Ball 20, in the embodiment illustrated, is made of Delrin™, a polyformaldehyde acetal resin sold by E.I. DuPont de Nemours & Company, though other moldable plastics such as polyethylene or polycarbonate are also acceptable. It is preferable, however, that ball 20 be provided with a relatively smooth outer surface for allowing ball 20 to be engageably movable within recess 18 and along side seating surfaces 21.

One end 23 of a mounting arm 22 is threaded or otherwise fastened into a bore 25 defined in ball 20, bore 25 being oppositely situated from the portion of ball 20 which is engaged into recess 18. The remaining end 27 of mounting arm 22 extends upwardly, in the embodiment illustrated, and is engaged into lower end 29 of a cylindrical supporting member 26. The other or upper end 31 of supporting member 26 is inserted into a force-application member 32, having a centrally disposed sleeve 30. In the embodiment illustrated, supporting member 26 is shaped so as to be slidingly engageable within sleeve 30. To bias element 10 to be generally perpendicular to axis 74, Figure 5A, a helical spring 24, having a length L1, is positioned between upper surface 4 and a lower surface 33 of force application member 32, and is circumferentially disposed about supporting member 26. Force application member 32 is mechanically attached to an analyzer (not shown). In the embodiment illustrated, ball 20, mounting arm 22, spring 24, supporting member 26, and force application member 32 can be made part of transfer element 10, or be part of the analyzer, the remainder of which is not shown. It can be seen that other available means of making the transfer element pivotable can be used, such as by providing supporting member 26 from a flexible material so as to allow it to bend from a neutral position.

Figures 3A, 3B, 4A, 4B, 5A, 5B and 6 illustrate a method of dispensing a quantity of liquid sample, such as blood serum, on to a test element which permits the quantitative analysis of analytes in the liquid sample using the apparatus discussed above and illustrated in Figures 1 and 2.

Turning to Figures 3A and 3B, transfer element 10 is placed into a container 34 containing a patient liquid 36. The location and requirements of container 34 can be varied such that it may be positioned at a station within the confines of a clinical analyzer, or alternatively in an off-line position. Container 34, in terms of location or configuration, is not considered an essential element of the present invention.

Transfer element 10 is first lowered into container 34, as illustrated in Figure 3B, immersing lower surface 6 to a level in which grooves 8 of liquid-supporting portion 7, if present, can acquire contained patient liquid 36 thereupon. Most of the air contained within grooves 8 is vented outwardly of transfer element 10 through venting channels 12, Figure 2A. Transfer element 10 is then withdrawn from container 34. As shown in Figure 4A, as transfer element 10 is removed from container 34 a quantity of liquid 44 is retained on supporting portion 7, such as within grooves 8 due to the adhesion of fluid to ribs 14.

As transfer element 10 is withdrawn from container 34 a meniscus 41, containing an excess of patient liquid in addition to quantity 44, Figure 4B required to fill grooves 8, forms on lower surface 6 due to the surface tension of the patient liquid. It is preferable that meniscus 41 be removed prior to the dispensing of liquid from transfer element 10 in order to avoid potential flooding of the test slide element when liquid is transferred, and further to more adequately control the volume of liquid to be applied thereto.

Container 34, preferably, provides means for scraping against lower surface 6 to wipe excess liquid from surface 6 and grooves 8. Specifically, an edge 38 is provided with a knife edge 35 as shown in Figure 4A and 4B. Beginning at one side of liquid-supporting portion 7, transfer element 10 can be drawn,in the direction of arrow 42, along knife edge 35, to remove meniscus 41, Figure 4B, leaving a uniform layer of patient liquid 44 within grooves 8. As lower surface 6 is drawn across knife edge 35 the excess fluid comprising meniscus 41 is squeegeed from one side of lower surface 6 to the other while a quantity of fluid 44 within grooves 8 remains. In addition, the external energy supplied to grooves 8 by scraping knife edge 35 against surface 6 serves to evacuate air pockets formed

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within grooves 8, allowing the grooves to fill with liquid.

Any small portion of meniscus 41 remaining along the outer peripheral edge 16 of ring portion 11 after lower surface 6 has been drawn along knife edge 35 can then be wicked by the circumferentially disposed absorbent disc 17, positioned adjacent outer edge 16.

Knife edge 35 can be made from known materials. Alternatively, scraping apparatus 38 can be made part of the analyzer, such as if container 34 is located off-line.

In this way, a known volume of liquid material 44, as defined by the size and number of grooves 8, is uniformly supported by surface 6 prior to transferring liquid material to a test element. In the embodiment illustrated, a quantity of 2μl is retained within grooves 8, over a diameter D1 of 4mm.

Turning to Figures 5A and 5B, transfer element 10 is positioned over a test element 50 having a plastic support frame 52, and a centrally disposed chemistry portion 58 having a circular configuration, a test volume V subtending test surface area S, and having a diameter D3. The chemistry portion 58 further comprises dried reagents distributed through two layers 60, 61 on a support 54. In the embodiment illustrated, D3 is also 4mm.

Referring to Figures 5A, 5B and 7, transfer element 10 is lowered until ribs 14 are brought into contact with chemistry portion 58, and specifically, reagent layer 60. As noted above, liquid-supporting portion 7 of lower surface 6 has a diameter D1 which is preferably at least equal to diameter D2, Figure 5B, Figure 7, of detection target area 59 of chemistry portion 58. In the embodiment illustrated, chemistry portion 58 has a diameter D1 of 4mm and detection target area diameter D2 is equal to 3mm. Such equality of diameters removes the need to have horizontal spreading of the liquid across test volume V.

Referring to Figure 5A, downward pressure in the amount of force F is then exerted by force applicating member 32, as shown by arrow 66, substantially along a vertically extending centerline 74. As force F is applied supporting member 26 is further engaged into sleeve 30 and the distance between surface 33 and upper surface 4 is decreased to L2, placing helical spring 24 into compressive contact with upper surface 4, centrally distributing the applied compressive force F to transfer element 10. The effect of providing compressive force F is that liquid-supporting portion 7 and chemistry portion 58 are also brought into compressive contact.

Under force F, liquid 44 contained within each of grooves 8 is then uniformly communicated to the entirety of test surface area S of test volume V, effectively blotting the entire test surface area S all at once as a surface-dispersed quantity, as defined, upon removal of transfer element 10, FIG 5B. Liquid 44 is then quickly absorbed (or vertically diffused) by porous reactant layers 60, 61. The representation in Figure 5B illustrates the instantaneous dispensing of liquid prior to the complete vertical absorption into porous layers 60, 61. In addition, disc 17 is effective in absorbing excess liquid from outer peripheral edge 16 when each of the surfaces are brought into compressive contact, so as not to flood test element 50. Ring portion 11, having a surface 9 which is flush with edges 14, however, provides a barrier so that only excess liquid is wicked by disc 17 upon contact.

Figure 6 illustrates an optional pivotability feature of transfer element 10 in the event that slide element 50 is not aligned with respect to lower surface 6. According to Figure 6, the position of slide element 50 defines a plane 70, plane 70 being skewed from vertical centerline 74 such that plane 70 is not orthogonal thereto. As liquid-supporting portion 7 contacts chemistry portion 58 of slide element 50 at one end 72, transfer element 10 is made to pivot about centerline 74 due to downward force F, thereby allowing surface 6 to align substantially parallel to plane 70 as ball 20 impinges upon side surfaces 21 of recess 18 allowing transfer element 10 to rotate counterclockwise, as illustrated by arrow 71, until surface 6 contacts end 75.

The compressive load levels applied also insures chemistry portion 58 will not be damaged. In the embodiment illustrated, a compressive force of 0.14N (0.5ozf) is sufficient to transfer a patient liquid to chemistry portion 58 without damage thereto. The amount of force required, however, can be varied depending upon material properties and the fragility of the chemistry portion provided. In addition, rounding the ribs 14 of liquid-supporting portion 7 is also preferable to avoid damage to chemistry portion 58. Transfer element 10 is then withdrawn from slide test element 50 as illustrated in Figure 5B, by arrow 69.

The method herein described eliminates the need for a spreading layer to horizontally diffuse the patient fluid throughout reagent layers 60, 61 in that the liquid sample has been effectively and uniformly distributed over the entire surface area, all at once, as a surface-dispersed quantity to the test volume V of element 50 to permit detection of the analyte of interest. Thereby the manufacture of test slide elements, and in particular the manufacture of the chemistry portion contained therein, is simplified.

A direct advantage realized by delivering the liquid sample as a surface-dispersed quantity is graphically illustrated in Figures 8A and 8B. Figure 8A depicts a generalized plot of sample concentra-

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tion (denoted as C) versus horizontal radial distance from centerline 74, Figure 5A for a point source dispensing system as typically described above. As noted by the plot, at time t_0 the concentration level C begins to become variable markedly at approximately 2mm, which is approximately the dimension of the pipette tip exterior diameter as the tip vertically delivers the sample as a single droplet to the test element. A variable level of C is thereafter found as R increases outwardly due to the outward spread of the variably viscous sample liquid from the centrally disposed droplet.

At some later time, t_1, there is a tendency for the concentration gradient to equilibrate, or redistribute, to some degree due to diffusion, as represented by the dashed profile. In the embodiment illustrated, t_1 is 1 to 5 minutes, though the time taken to equilibrate, or redistribute can be varied depending upon the diffusivity of compounds used. Such a transient change in the concentration level can directly affect the detection results as read by an analyzer, particularly in rate-type chemistries. Further, the time required for complete equilibration is lengthy and generally unpredictable due to the makeup of individual samples.

By delivering a surface-dispersed quantity all at once to test volume V, Figure 5A, a relatively constant concentration level C is provided over the entirety of test surface area S, Figure 5A, shown generally by Figure 8B. Further, there is no need for the liquid level delivered to equilibrate and no significant and artificial rate change is produced, such as shown in Figure 8A.

Referring to Figure 7, a further advantage provided by the present invention is shown. The chemistry portion 58', of a typical test element 50, having a sample dispensed from a point source (not shown), has a diameter D4 of at least 11mm to provide a detection or read area 59 having a diameter D2 of 3mm. The present invention, however, by delivering a quantity of patient liquid all at once to an area at least equal to detection area 59 requires a smaller chemistry portion 58. In the embodiment illustrated, chemistry portion 58 has a diameter D3 of 4mm, or roughly the same size D1 of lower surface 6. As noted above, because a much smaller chemistry portion is required, a correspondingly smaller quantity of sample is required to fill the volume. In the embodiment described, approximately 2µl is required to fill the smaller chemistry portion 58, as opposed to 10µl or more being required for point source dispensing systems having larger chemistry portions.

In another embodiment, a quantity of a liquid diluent can be directly applied all at once to the chemistry portion of a test element using the method and apparatus described herein, prior to the application of a patient sample. This particular embodiment is described in detail in co-pending European patent application no. _____ filed concurrently herewith and corresponding to USSN 094722 filed 21 July 1993 and entitled "Method of Pretreating Diagnostic Test Elements".

Claims

1. A method of dispensing a liquid sample on to a test element (50, 52, 54, 60, 61) having a test volume (V) subtending a surface area (S) for that volume for receiving the liquid sample, the method comprising the steps of:-
   a) applying on to a transfer element (10) having a liquid-supporting surface (7) for supporting a liquid, a quantity of liquid sample over substantially all of the liquid-supporting surface (7); and
   b) placing the liquid-supporting surface (7) of the transfer element (10) in contact with all of the surface area (S) of a test element (50, 52, 54, 60, 61) at once, thereby transferring the liquid sample as a surface-dispersed quantity to the test element (50, 52, 54, 60, 61) without the need for extensive horizontal flow over the surface area (S) of the test element (50, 52, 54, 60, 61).

2. A method according to claim 1, further comprising the step of removing excess liquid material from the liquid-supporting surface (7) of the transfer element (10) prior to step b).

3. A liquid dispensing device for dispensing a liquid sample on to a test element (50, 52, 54, 60, 61) having a test surface (S), the device comprising:-
   a main body portion (2);
   a transfer portion (6, 7, 8) supported by the main body portion (2) for engagement with a test element (50, 52, 54, 60, 61), the transfer portion (6, 7, 8) having a liquid-impermeable supporting surface (7) for supporting a liquid over an area (D1) approximately equal to the area (D3) of the test surface (S) of the test element (50, 52, 54, 60, 61); and
   absorbing means (17) disposed about the periphery of the transfer portion (6, 7, 8) for absorbing excess liquid from the liquid-impermeable supporting surface (7) prior to dispensing therefrom.

4. A device according to claim 3, further comprising pivotable adjusting means (18, 20, 21) for pivotably adjusting the transfer portion (6, 7, 8) to compensate for misalignment with the test surface (S) of a test element (50, 52, 54, 60, 61) ensuring substantial contact therewith for

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dispensing thereto.

5. A device according to claim 4, further comprising biasing means (24) for biasing the transfer portion (6, 7, 8) to be generally perpendicular to a central axis (74), the biasing means (24) cooperating with the pivotable adjusting means (18, 20, 21) to hold the liquid-impermeable supporting surface (7) in contact with the test surface (S) of the test element (50, 52, 54, 60, 61).

6. A device according to any one of claims 3 to 5, wherein the liquid-impermeable supporting surface (7) of the transfer portion (6, 7, 8) comprises a plurality of grooves (8) sized to support a quantity of liquid for dispensing.

7. A device according to any one of claims 3 to 6, wherein the absorbing means (17) comprises at least one strip of absorbing material, the strip being disposed about at least a portion of the periphery of the transfer portion (6, 7, 8) and in contact with at least a portion of the liquid-impermeable supporting surface (7).

8. A device according to any one of claims 3 to 7, further comprising wiping means (35, 38) for wiping excess liquid material from the liquid-impermeabl supporting surface (7) prior to contacting a test element (50, 52, 54, 60, 61).

9. A device according to claim 8, wherein the wiping means (35, 38) comprises a knife edge fixture (38) sized so that the liquid-impermeable contacting surface (7) can be scraped against the knife edge fixture (38) to remove excess liquid material prior to contacting with the test element (50, 52, 54, 60, 61).

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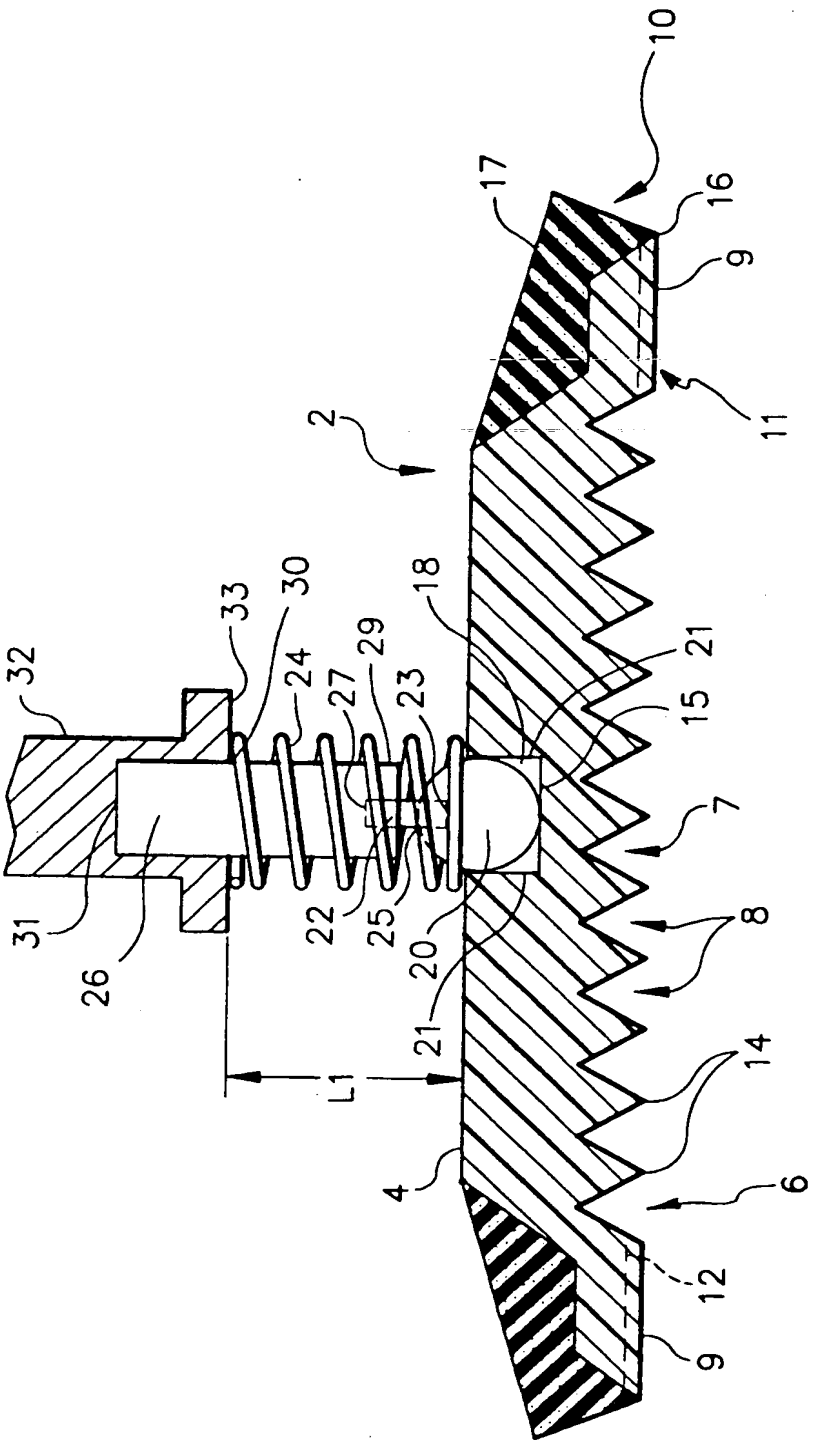

FIG. 1

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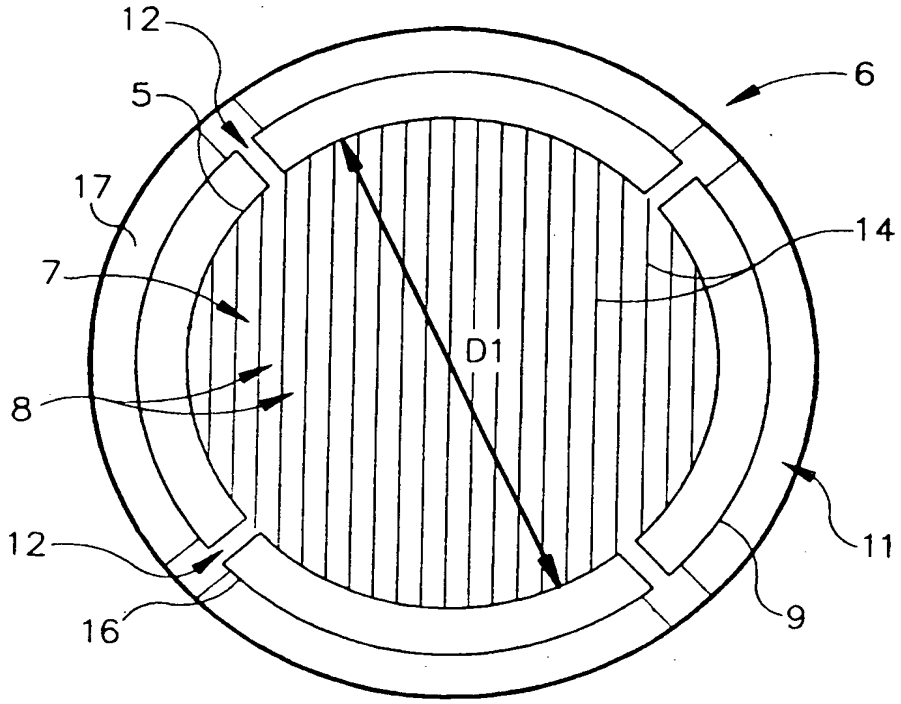

FIG. 2A

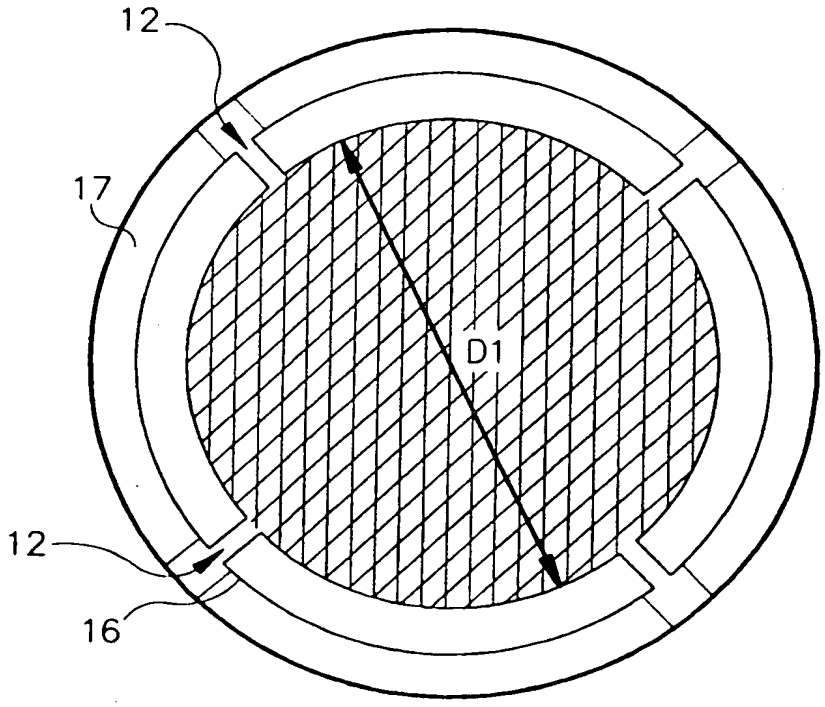

FIG. 2B

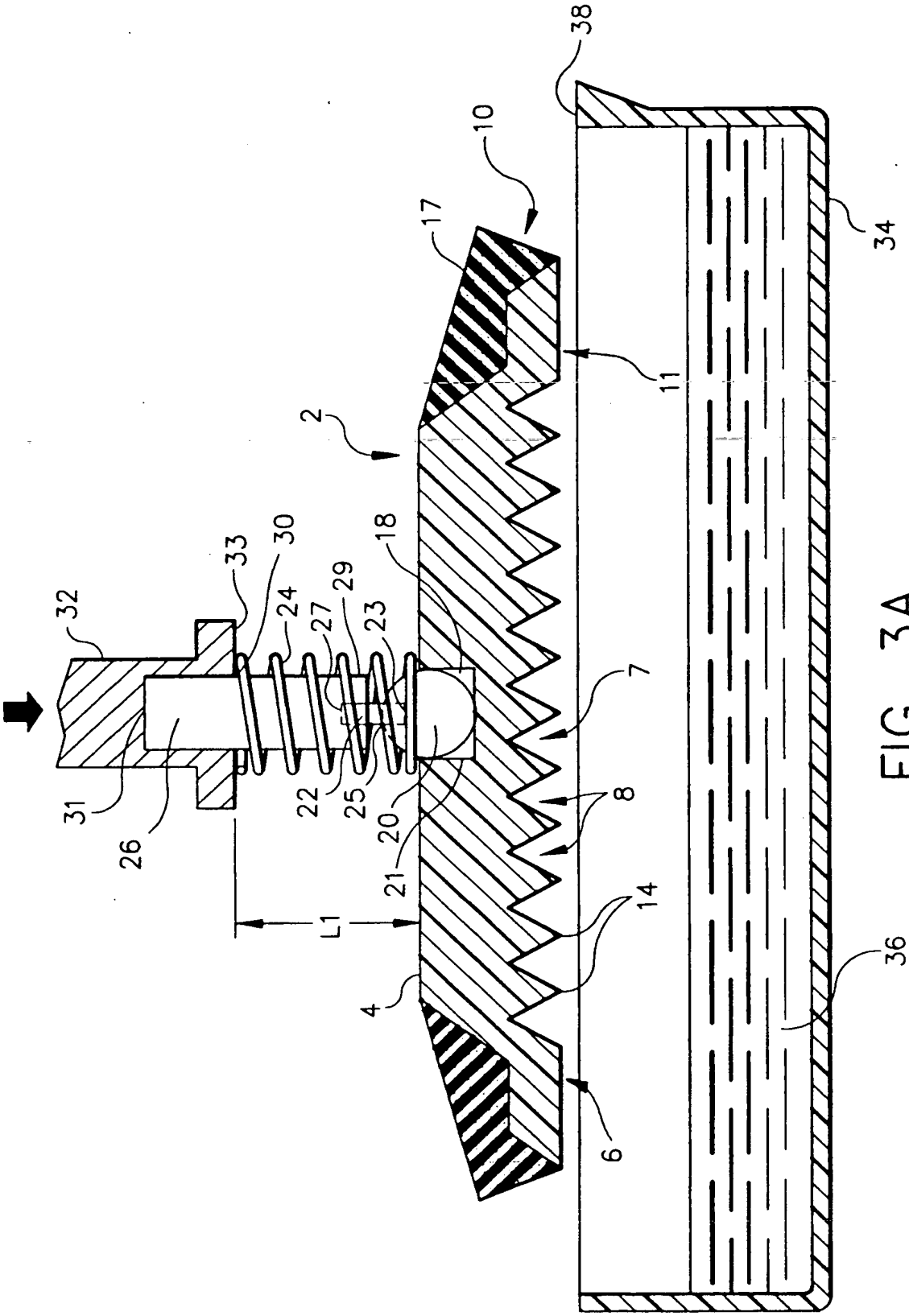

FIG. 3A

BNSDOCID: <EP___0635710A2_I_>

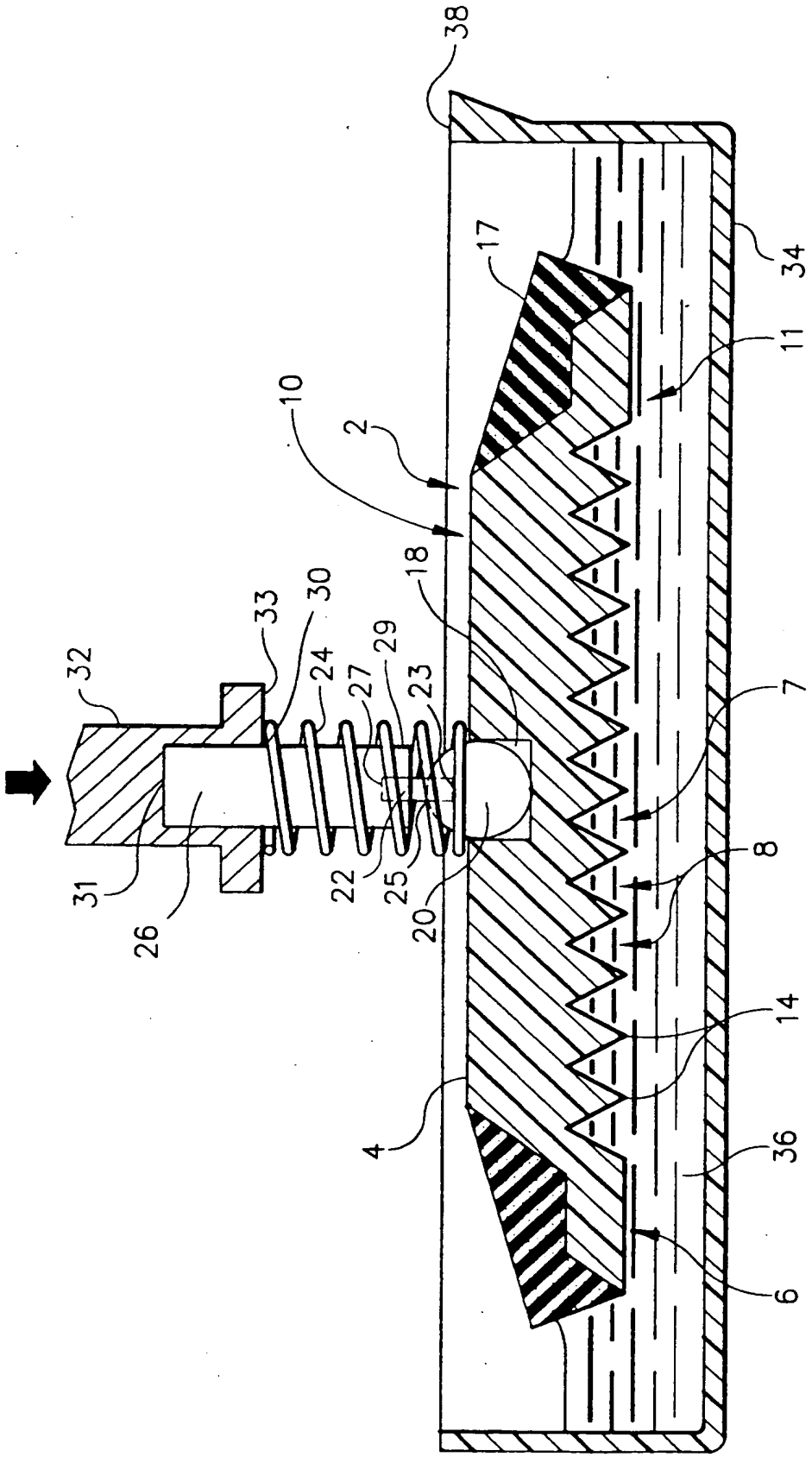

FIG. 3B

BNSDOCID: <EP___0635710A2_I_>

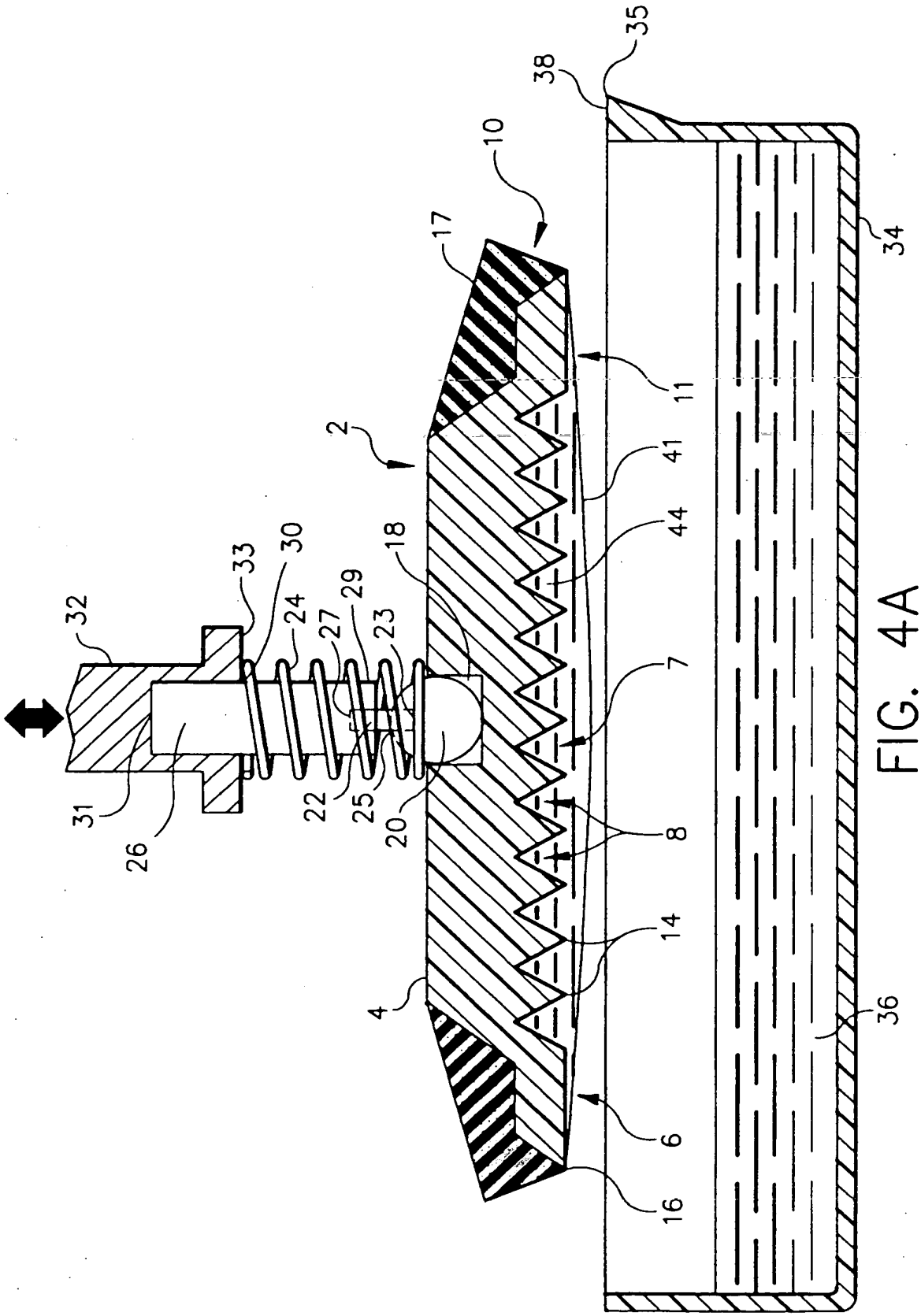

FIG. 4A

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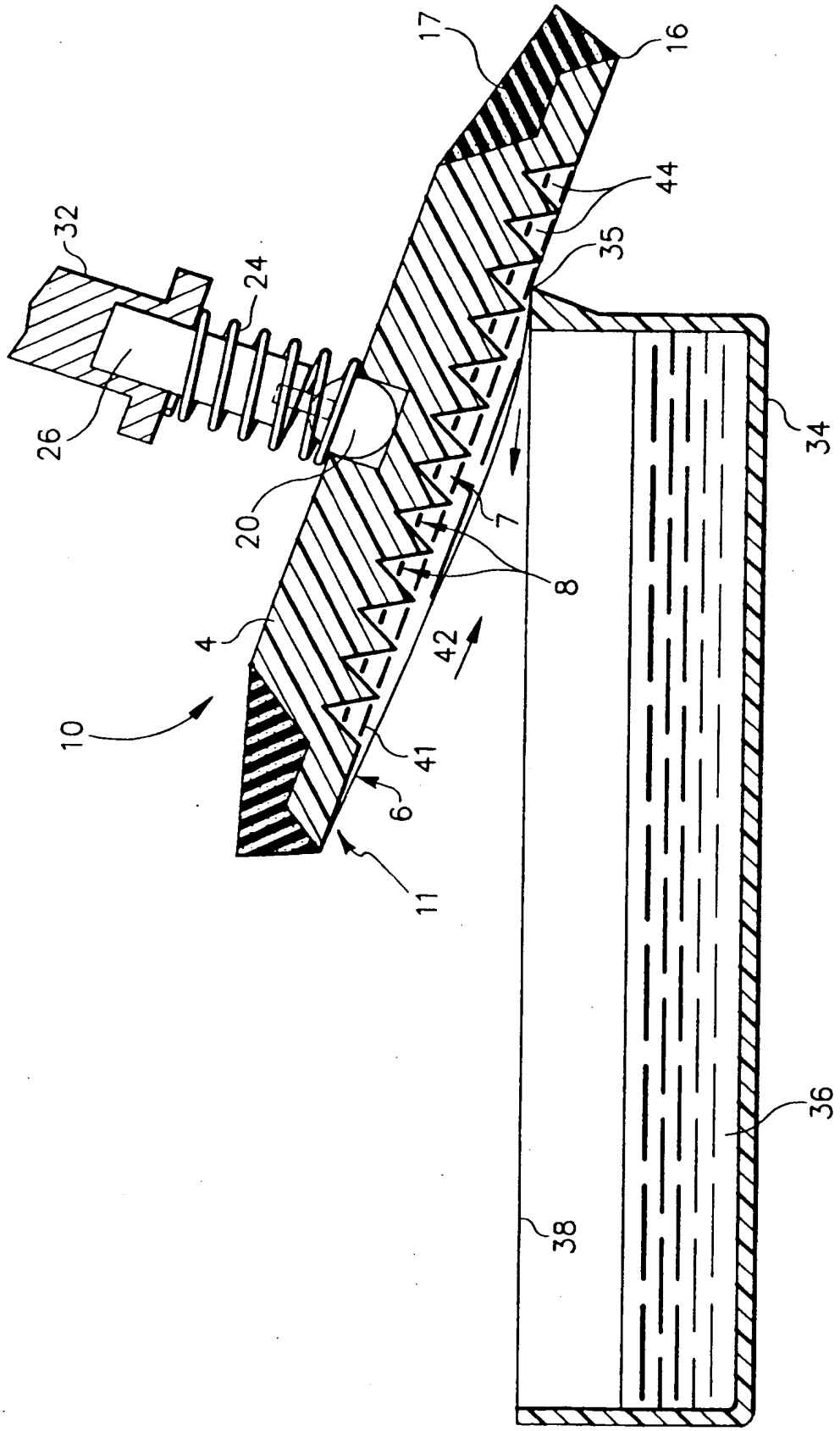

FIG. 4B

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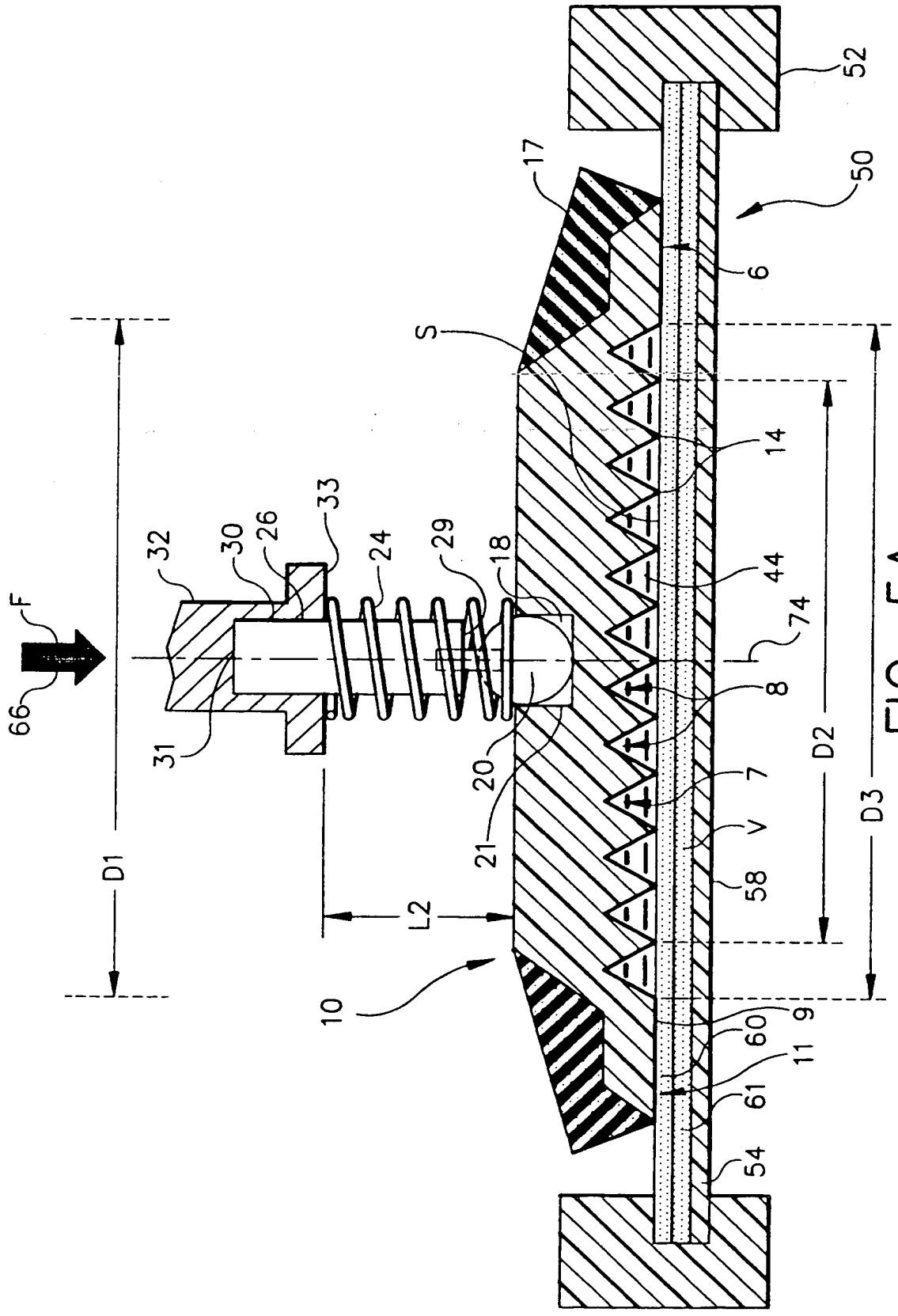

FIG. 5A

BNSDOCID: <EP___0635710A2_I_>

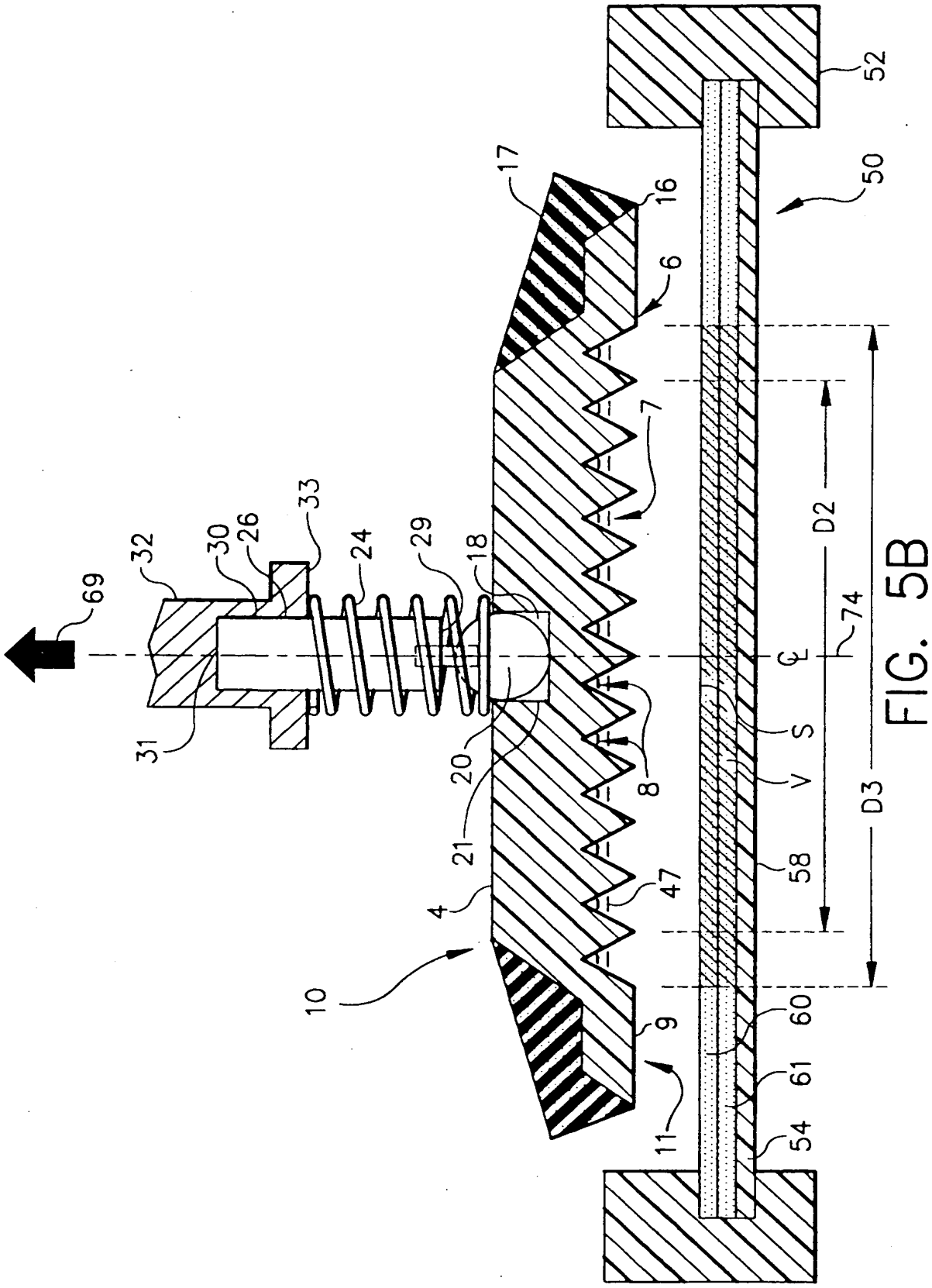

FIG. 5B

BNSDOCID: <EP___0635710A2_I_>

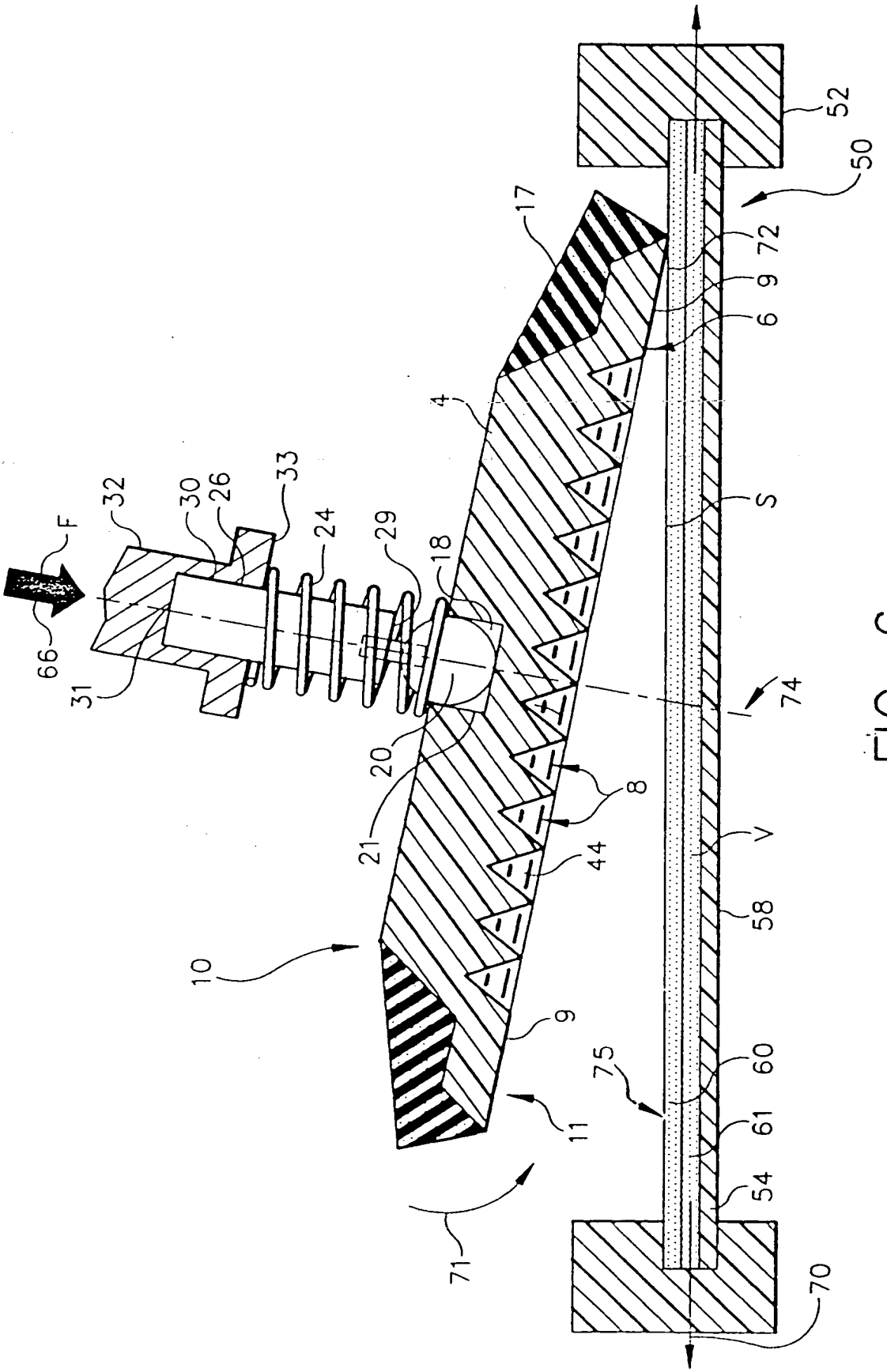

FIG. 6

BNSDOCID: <EP___0635710A2_I_>

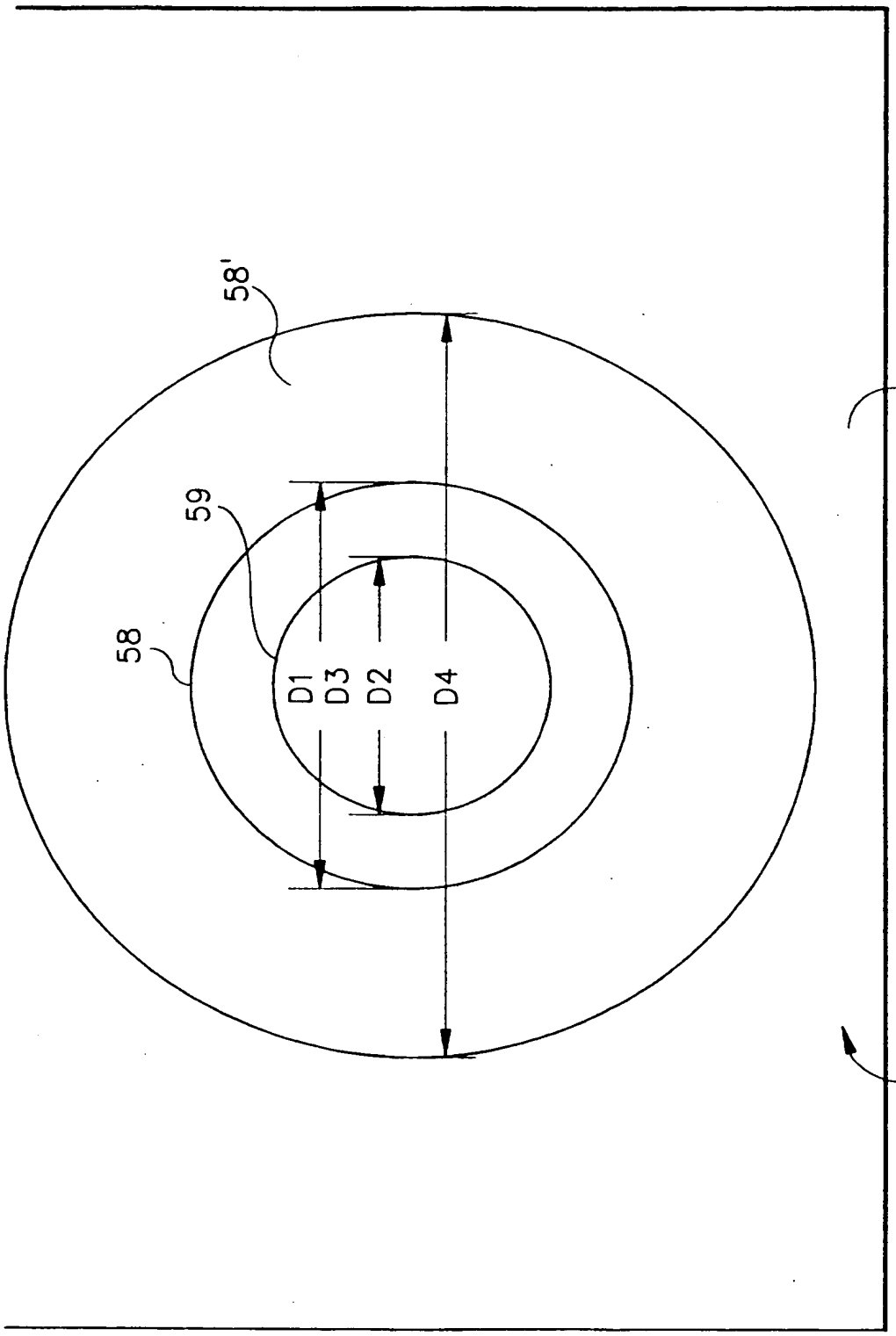

FIG. 7

BNSDOCID: <EP___0635710A2_I_>

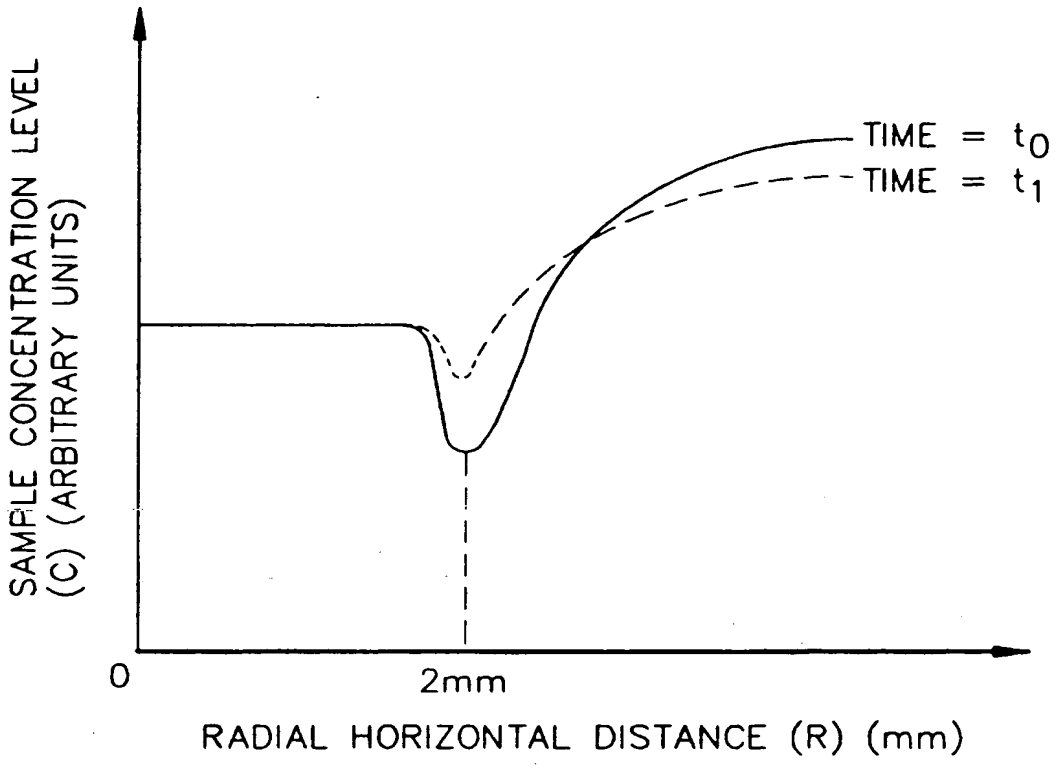
SAMPLE CONCENTRATION LEVEL
(C) (ARBITRARY UNITS)
TIME = t_0
TIME = t_1
0
2mm
RADIAL HORIZONTAL DISTANCE (R) (mm)

FIG. 8A

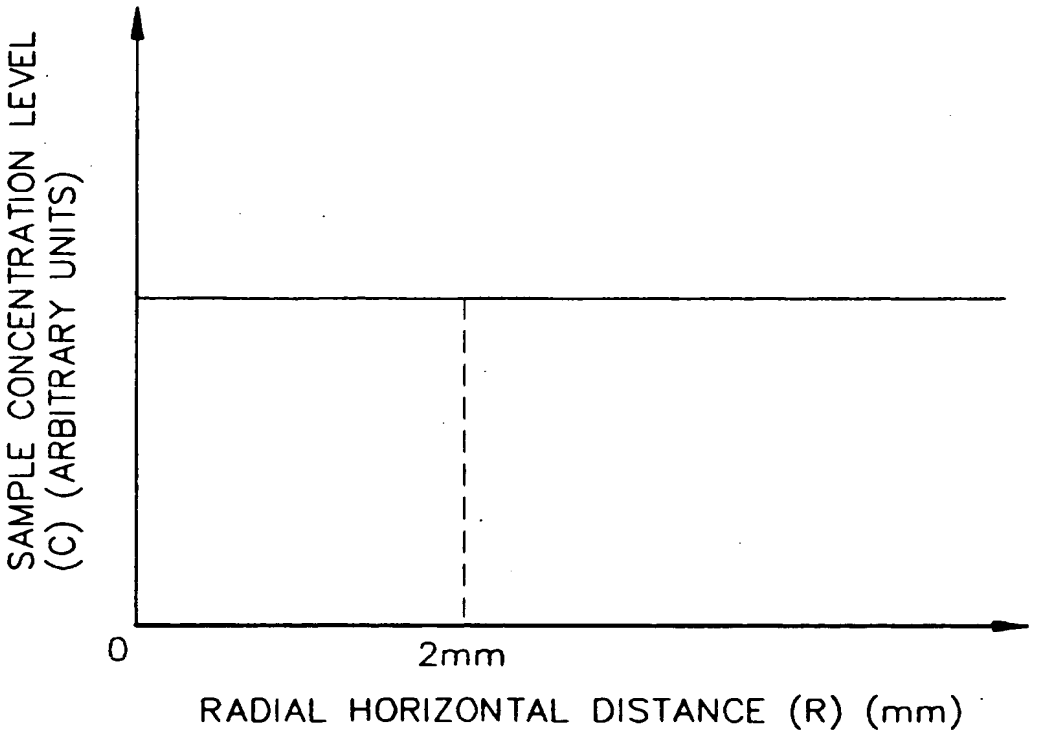
SAMPLE CONCENTRATION LEVEL
(C) (ARBITRARY UNITS)
0
2mm
RADIAL HORIZONTAL DISTANCE (R) (mm)

FIG. 8B

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(54) Method and apparatus for surface area liquid transfer.

(57) It is known in clinical analyzers to dispense patient sample on to a test element using metering pipettes. Dispensing using such pipettes may introduce problems, such as, flow irregularities in the test element, which influence the reliability of the test results obtained. Described herein is apparatus and method for uniformly transferring a liquid material to a test element in which a transfer element (10) having a body portion (2) and a liquid-impermeable supporting surface (6, 7, 8) which has an area approximately equal to the surface area subtended by the test volume of the test element, is brought into direct contact with the test surface of the test element so that the liquid is transferred instantaneously over the entirety of the surface area of the test element.

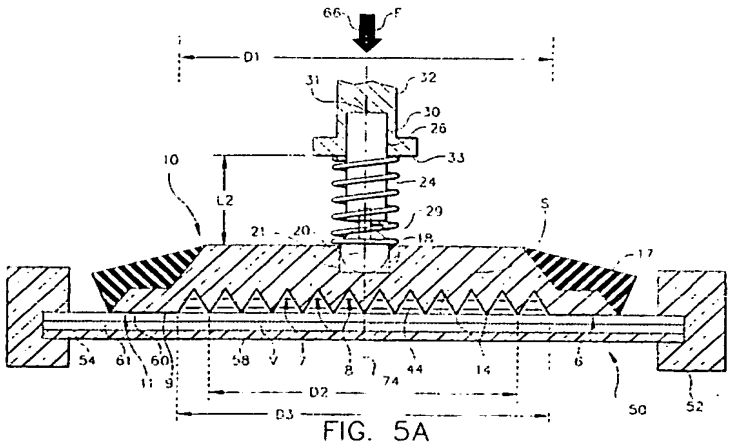

FIG. 5A

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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 20 2115

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y A	GB-A-2 095 404 (FUJI PHOTO FILM CO LTD) 29 September 1982 * the whole document *	1 2-6,8,9	G01N35/00 G01N1/28 B01L3/02
Y	EP-A-0 376 110 (BOEHRINGER MANNHEIM GMBH) 4 July 1990 * column 3, line 53 - column 4, line 25; figures 1,2 *	1	
Y	EP-A-0 075 605 (STOCKER WINFRIED DR MED) 6 April 1983 * page 12, line 5 - line 11 * * page 13, line 6 - line 20 * * figure 3, item 3 001c *	1	
A	WO-A-91 01364 (IMP CANCER RES TECH) 7 February 1991 * page 3, line 12 - page 6, line 17; figures 1,2 *	1,3,6	
A	EP-A-0 459 093 (BECTON DICKINSON CO) 4 December 1991 * column 7, line 42 - line 52 * * column 9, line 54 - column 10, line 2; figure 1 *	1-4	TECHNICAL FIELDS SEARCHED (Int.Cl.6) G01N B01L
A	DE-C-33 41 518 (BIOTEST-SERUM INSTITUT GMBH) 18 April 1985 * figures 1,5 *	3-5	
A,D	US-A-5 143 849 (J.V. BARRY ET AL.) 1 September 1992		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 February 1995	Hodson, M

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